

Field Report for Airborne Data Collected In Support of US EPA Region VI Valley Feed Mill Fire 25 September 2018

Background

On 25 September 2018 a large fire developed at the Valley Feed facility located in Winnsboro, TX. Local news outlets report that the blaze started at about 1130 (local) and has generated visible flames, smoke and a strong chemical smell. Local response authorities have imposed a 1.5 mile evacuation due to possible chemical hazards. Officials expect to let the fire burn itself out which may take several hours.

The US EPA Region VI requested that the ASPECT system be deployed to provide monitoring support at approximately 1445 on 25 September 2018. ASPECT was formally notified to launch at 1535 and was airborne at 1600. Travel time to the facility from the Addison base was estimated to be about 45 minutes.

The Valley Feed facility is on the eastern side of Winnsboro, TX about a 1.4 miles from the town center. The geographical coordinates of the facility are 32.9500N, 95.2693W (figure 1). The area is located in semi-rural area with isolated housing developments within 1 km of the site.

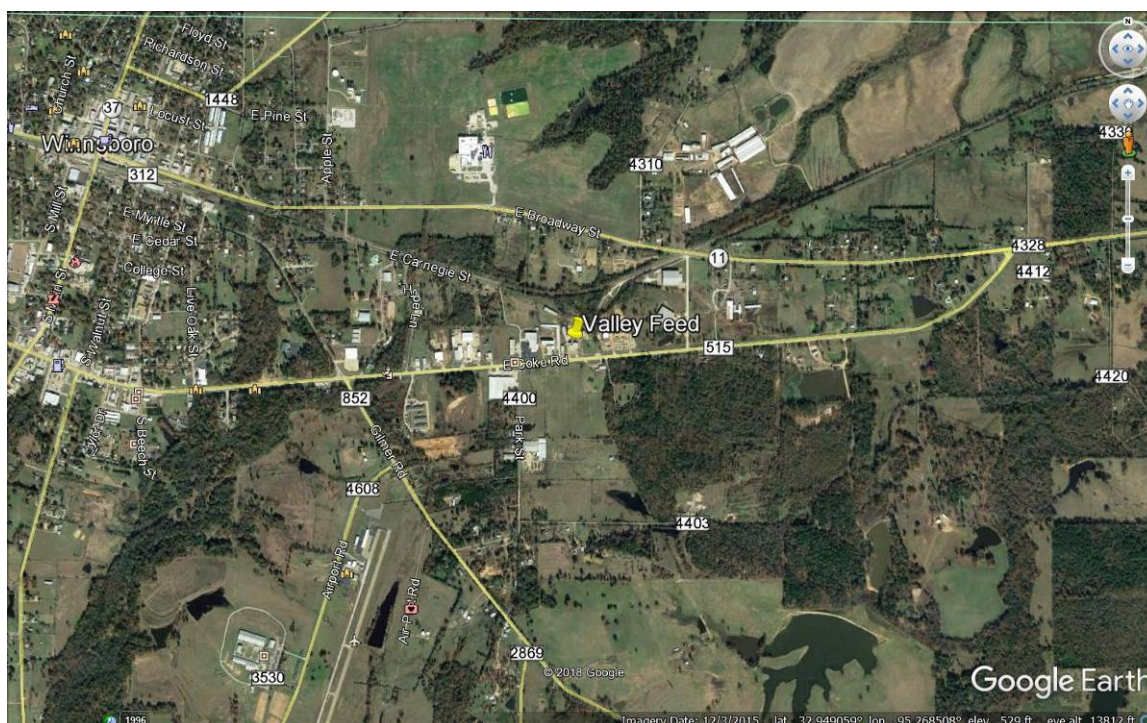


Figure 1: Valley Feed, Winnsboro, TX

ASPECT response to this Mission/Incident was in support of:
US EPA Region 6. OSC: Mark Hayes

ASPECT System

The US EPA ASPECT system collects airborne infrared (IR) images and chemical screening data from a safe distance over the site (about 3,000 ft AGL). The system consists of an airborne high speed Fourier transform infrared spectrometer (FTIR) coupled with a wide-area IR line scanner (IRLS). The ASPECT IR systems have the ability to detect compounds in both the 8 to 12 micron (800 to 1200 cm⁻¹) and 3 to 5 micron (2000 to 3200 cm⁻¹) regions. The 8 to 12 micron region is typically known as the atmospheric window region since the band is reasonably void of water and carbon dioxide influence. Spectrally, this region is used to detect carbon - non-carbon bonded compounds. The 3 to 5 micron region is also free of water and carbon dioxide but typically does not have sufficient energy for use. This band does show use in high-energy environments such as fires. The carbon - hydrogen stretch is very common in this region.

A digital Nikon DX2 camera (12.4 mega pixel CMOS 3:5 aspect ratio, 28 mm wide-angle lens) collects visible aerial imagery as part of the core data product package. The camera timing system is connected to the primary IR sensors and provides concurrent image collection when other sensors are triggered. All imagery is geo-rectified using both aircraft attitude correction (pitch, yaw, and roll) and GPS positional information. Imagery can be processed while in flight or approximately 600 frames per hour can be processed once the data are downloaded from the aircraft.

An Imperx mapping camera (29 mega pixels; mapping focal plane array) provides a similar aspect ratio and aerial coverage. Like the Nikon DX2, it is connected to the primary IR sensors and provides concurrent image collection when other sensors are triggered. These images are often digitally processed in lower resolution so they can be transmitted via satellite communication. The high resolution images (>20 MB each) are pulled from the ASPECT after the sortie and are available at a later time.

All aerial photographic images collected by the ASPECT system are ortho-rectified and geospatially validated by the reachback team. In general, this consists of conducting geo-registration using a Digital Elevation Model (DEM) which promotes superior pixel computation and lessens topographic distortion. The image is then check by a team member (using a Google Earth base map) for proper location and rotation

Data is processed using automated algorithms onboard the aircraft with preliminary results being sent using a satellite system to the ASPECT reachback team for QA/QC

analysis. Upon landing preliminary data results are examined and validated by the reachback team.

Weather Conditions and Crew Report

Weather for the mission is given in table 1.

Table 1. Valley Feed Fire Mission Weather

Parameter	surface (1530)	Surface (1700)	Surface (1945)
Wind direction	180 degrees	190 degrees	180 degrees
Wind speed	1 m/s (1.5 kts)	1 m/s (1.5 kts)	1 m/s (1.5 kts)
Temperature	32°C	32.2°C	26.1°C
Humidity	56%	59%	78%
Dew Point	22.2°C	22.2°C	22.2°C
Pressure	1011 mb	1011 mb	1011 mb
Ceiling	1070 m (3500 ft)	1070 m (3500 ft)	Clear

The crew reported that winds at altitude (2800 ft) were from 170 degrees at 3.5 m/s (7 kts). Smoke emitted from the fire was reported to be gray in color was staying close to the ground. Plume movement was generally toward the north.

Flight Status

The order to launch the aircraft was given 1510 local on 25 September 2018 and the aircraft was airborne at 1600. The initial data collection run over the site was at 1633 (local) The aircraft made a total of 14 data collection passes; flight information is summarized in Appendix A and Figure 2.

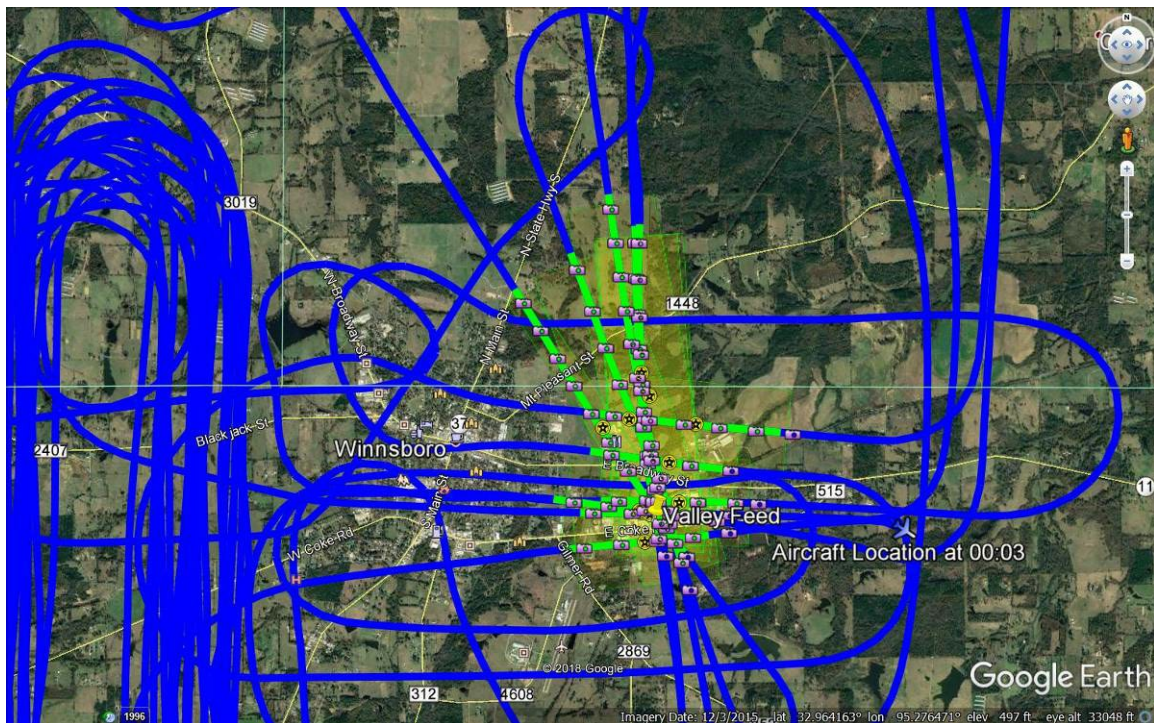


Figure 2: Data collection passes, Valley Feed Fire, Winnsboro, TX. The blue lines represent the ASPECT flight path, green lines represent when the Infrared Line Scanner was actively collecting data, and the camera icons represent when a photo was taken.

Data Results

General Data Quality Objective

The following general data quality objectives are employed in conducting emergency response data collection with ASPECT:

1. To support overall situational analysis of the incident including aerial photography and IR imagery
2. To screen the incident for the presence of selected chemicals
3. To estimate the location and concentration of plumes being generated by the incident.

Line Scanner Data Results

A total of 1 test and 13 data passes were made in the proximity of the site and an infrared line scanner images were generated for each pass. Figure 3 shows a typical 3-band infrared image obtained from data collected for Run 6. The highlighted area shows the location of the facility. Examination of the detail shows slightly elevated temperatures in relation to the surrounding area (white is hot). personnel had foamed the fire and greatly reduced the thermal signature of the fire. An IR plume was not observed on any of the collection flights.



Figure 3: – 3 band IR image, Run 6, Valley Feed

FTIR Data Results

FTIR Spectral data at a resolution of 16 wavenumbers was collected for each pass. ASPECT uses an automated detection algorithm to permit compounds to be analyzed while the aircraft is in flight. 78 compounds are included in this algorithm and the list and associated detection limits are given in Table 2. In addition, collected data are also manually analyzed by comparing any detected spectral signatures to a collection of published library spectra.

Ammonia was detected on this mission and the detection of 2.2 ppm was just above the detection limit for the system (figure 4 and table 3). Figure 5 shows the spectra of the detection with characteristic peak near 930 and 960 wavenumbers. The peak near 850 wavenumbers is CO₂. It should be noted that the apparent baseline shift of the data is

due to the passive nature of the data. The concentration reported by the system is likewise confirmed due to the low signal to noise ratio (approximately 3) of the data. The detection was made downwind of the fire as part of data run 5.

Manual analysis of the data showed the presence of low levels of Nitrous Oxide (N₂O) in passes near the fire (figure 6). N₂O has two peaks in the long wave region consisting of 1220 and 1280 wavenumbers. The large feature centered on 1080 wavenumbers is peroxyacetyl nitrate (PAN) a compound associated with the incomplete combustion of nitrogen rich materials. No other data passes showing detectable results for any other compounds.

TABLE 2 - Chemicals Included in the ASPECT Auto-Processing Library

Acetic Acid	Cumene	Isoprene	Propylene
Acetone	Diborane	Isopropanol	Propylene Oxide
Acrolein	1,1-Dichloroethene	Isopropyl Acetate	Silicon Tetrafluoride
Acrylonitrile	Dichloromethane	MAPP	Sulfur Dioxide
Acrylic Acid	Dichlorodifluoromethane	Methyl Acetate	Sulfur Hexafluoride
Allyl Alcohol	Difluoroethane	Methyl Ethyl Ketone	Sulfur Mustard
Ammonia	Difluoromethane	Methanol	Nitrogen Mustard
Arsine	Ethanol	Methylbromide	Phosgene
Bis-Chloroethyl Ether	Ethyl Acetate	Methylene Chloride	Phosphine
Boron Tribromide	Ethyl Formate	Methyl Methacrylate	Tetrachloroethylene
Boron Trifluoride	Ethylene	MTEB	1,1,1-Trichloroethane
1,3-Butadiene	Formic Acid	Naphthalene	Trichloroethylene
1-Butene	Freon 134a	n-Butyl Acetate	Trichloromethane
2-Butene	GA (Tabun)	n-Butyl Alcohol	Triethylamine
Carbon Tetrachloride	GB (Sarin)	Nitric Acid	Triethylphosphate
Carbonyl Chloride	Germane	Nitrogen Trifluoride	Trimethylamine
Carbon Tetrafluoride	Hexafluoroacetone	Phosphorus Oxychloride	Trimethyl Phosphite
Chlorodifluoromethane	Isobutylene	Propyl Acetate	Vinyl Acetate

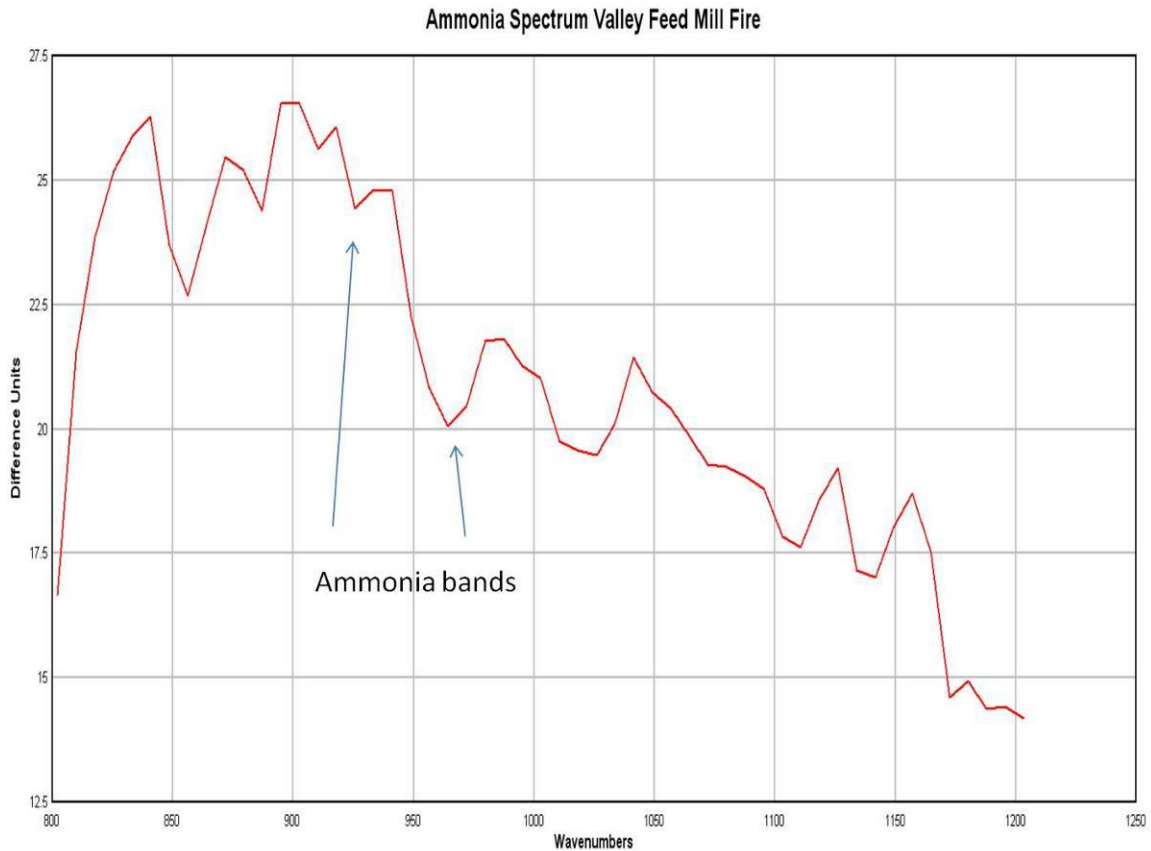


Figure 5: Ammonia Spectra, Run 5, Valley Feed Fire

Table 3. Chemical Results Summary

Run	Date	Time (UTC)	Chemical	Max Concentration ppm
1	25 Sept 2018	2124	Test	Test
2		2132	None	None
3		2137	None	None
4		2142	None	None
5		2148	None	None
6		2156	ammonia	2.2 ppm
7		2202	None	None
8		2209	None	None
9		2214	None	None
10		2343	N ₂ O	< 1 ppm
11		2353	None	None
12		0002	None	None
13		0012	None	None
14		0048	None	None

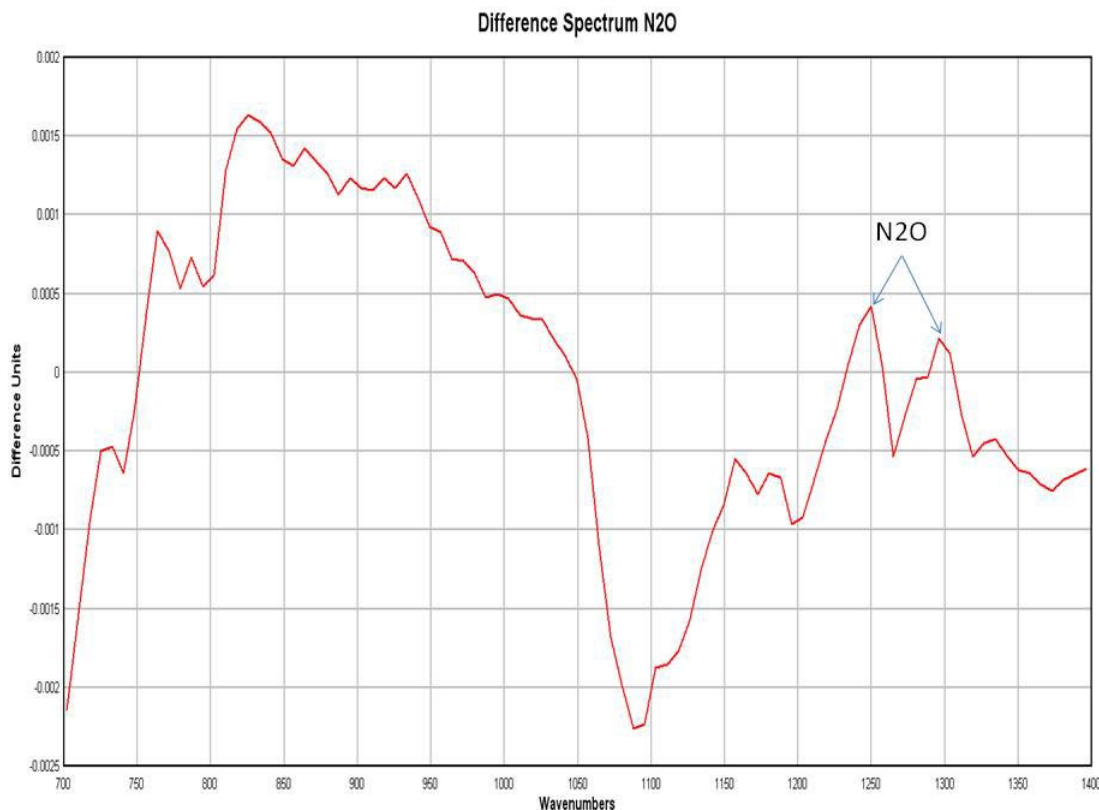


Figure 6: Nitrous Oxide Spectra, Run 14, Valley Feed Fire

Aerial Photography Results

A full set of high resolution aerial digital photography were collected as part of the flight. Figure 7 shows a representative image collected as part of Run 6. This image has been ortho-rectified with the top of the image being north. Examination of the photo shows a faint white plume drifting toward the north. (It should be noted that ground reports show the plume as light yellow) The low opacity of the plume indicates that the facility fire is nearing the final phase.

Figure 8 shows an example of an oblique image collected as part of the mission. This image was taken from the copilot station and is roughly looking to the northeast. A white and climbing plume is clearly evident in the image.

Conclusions

ASPECT was dispatched at the request of the EPA Region VI emergency response program to provide air monitoring of the Valley Feed fire. ASPECT arrived on-site at 1633 (local) and began the first of 14 data collection passes. Ammonia was

detected on pass 6 north of the fire at a concentration of 2.2 ppm. This estimated concentration was just above the detection limit of 2.0 ppm. Manual analysis of spectra indicated the presence of nitrous oxide at very low concentration (less than 1 ppm) and only near the fire. No other compounds were detected. IR imagery collected over the fire tended to show fairly low temperatures as a result of ongoing fire fighting operations. Reports on the fire indicate that the material involved in the fire was ammonium nitrate. The low detection of ammonia is consistent with the decomposition of the compound. In addition, the detection of N_2O (which is colorless) and the reported yellow plume (NO_2) is consistent with the thermal decomposition of ammonium nitrate.

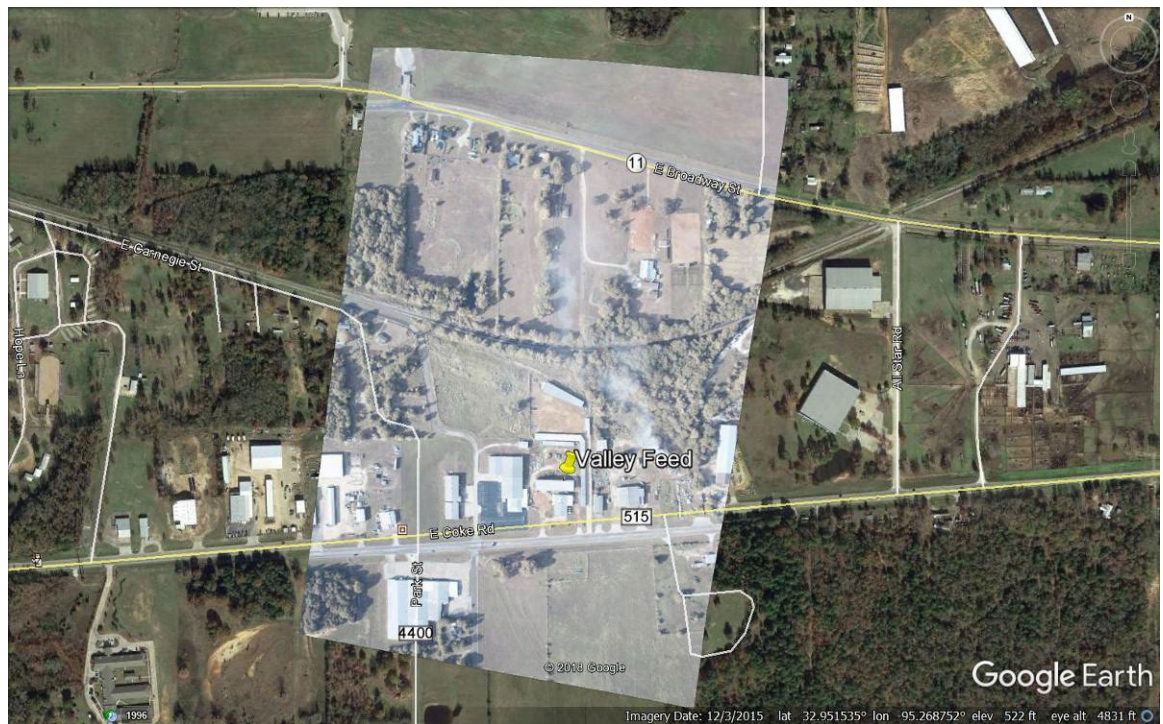


Figure 7: Aerial image Valley Feed Fire



Figure 8: Oblique image Valley Feed Fire

Appendix A

Abbreviations:

DEM – Digital elevation model
Alt – Altitude (in feet)
MSL – Mean sea level altitude (in feet)
Digital – Digital photography file from the Nikon D2X camera
MSIC – Digital photography file from the Imperx mapping camera
FTIR – Spectral IR data collected with a Fourier Transform
Infrared Spectrometer
IRLS – Infrared Line Scanner
Jpg – JPEG image format
UTC – Universal Time Coordinated
img – Spectral data format based on Grams format

Mission: 2018-09-25 Winnsboro Explosion

Date: 9/25/2018

Time UTC: 20:37

Aircraft Number: N9738B

Pilot: Beorn Ledger

Copilot: Todd Seale

Operator: Steven Brister

Aft Operator: Gerry Broyles

Ground Controller: Mark Thomas

DEM: Using elevation from DEM Database

Run: 1 Time: 21:24:27 UTC

Alt: 3470 ft MSL Elev: 445 ft Elevation from DEM Database

Vel: 166 knots Heading: 81

Digitals: None

MSIC: 3

20180925212433310.jpg

20180925212439675.jpg

20180925212446024.jpg

FTIR: 1

20180925_212431_A.igm

IRLS: 1

2018_09_25_21_24_31_R_01 TA=18.9;TB=39.0;Gain=3

Gamma Runs: None

Run: 2 Time: 21:32:53 UTC

Alt: 3482 ft MSL Elev: 505 ft Elevation from DEM Database

Vel: 120 knots Heading: 93

Digitals: None

MSIC: 5

20180925213259019.jpg

20180925213305384.jpg

20180925213311733.jpg

20180925213318083.jpg

20180925213321718.jpg

FTIR: 1

20180925_213257_A.igm

IRLS: 1

2018_09_25_21_32_57_R_02 TA=19.0;TB=39.0;Gain=3

Gamma Runs: None

Run: 3 Time: 21:37:55 UTC

Alt: 3378 ft MSL Elev: 509 ft Elevation from DEM Database

Vel: 124 knots Heading: 99

Digitals: None

MSIC: 4

20180925213801350.jpg

20180925213807715.jpg

20180925213814064.jpg

20180925213820429.jpg

FTIR: 1

20180925_213759_A.igm

IRLS: 1

2018_09_25_21_38_00_R_03 TA=19.0;TB=39.0;Gain=3

Gamma Runs: None

Run: 4 Time: 21:42:56 UTC

Alt: 3352 ft MSL Elev: 491 ft Elevation from DEM Database

Vel: 110 knots Heading: 99

Digitals: None

MSIC: 6

20180925214302784.jpg

20180925214309133.jpg

20180925214315498.jpg

20180925214321847.jpg

20180925214328197.jpg

20180925214334561.jpg

FTIR: 1

20180925_214300_A.igm

IRLS: 1

2018_09_25_21_43_01_R_04 TA=19.0;TB=39.0;Gain=3

Gamma Runs: None

Run: 5 Time: 21:48:46 UTC

Alt: 3440 ft MSL Elev: 497 ft Elevation from DEM Database

Vel: 113 knots Heading: 174

Digitals: None

MSIC: 9

20180925214852326.jpg

20180925214858676.jpg

20180925214905041.jpg

20180925214911390.jpg

20180925214917755.jpg

20180925214924104.jpg

20180925214930453.jpg

20180925214936818.jpg

20180925214943167.jpg

FTIR: 2

20180925_214850_A.igm

20180925_214930_A.igm

IRLS: 1

2018_09_25_21_48_51_R_05 TA=18.0;TB=38.0;Gain=3

Gamma Runs: None

Run: 6 Time: 21:56:45 UTC

Alt: 3363 ft MSL Elev: 503 ft Elevation from DEM Database

Vel: 111 knots Heading: 99

Digitals: None

MSIC: 5

20180925215651705.jpg

20180925215658054.jpg

20180925215704419.jpg

20180925215710768.jpg

20180925215717133.jpg

FTIR: 1

20180925_215649_A.igm

IRLS: 1

2018_09_25_21_56_50_R_06 TA=18.0;TB=38.0;Gain=3

Gamma Runs: None

Run: 7 Time: 22:02:39 UTC

Alt: 3497 ft MSL Elev: 504 ft Elevation from DEM Database

Vel: 104 knots Heading: 169

Digitals: None

MSIC: 11

20180925220244885.jpg

20180925220251234.jpg

20180925220257599.jpg

20180925220303948.jpg

20180925220310298.jpg

20180925220316662.jpg

20180925220323012.jpg

20180925220329361.jpg

20180925220335726.jpg

20180925220342076.jpg

20180925220348441.jpg

FTIR: 2

20180925_220242_A.igm

20180925_220321_A.igm

IRLS: 1

2018_09_25_22_02_44_R_07 TA=18.0;TB=38.0;Gain=3

Gamma Runs: None

Run: 8 Time: 22:09:40 UTC

Alt: 3481 ft MSL Elev: 506 ft Elevation from DEM Database

Vel: 112 knots Heading: 87

Digitals: None

MSIC: 5

20180925220946149.jpg

20180925220952514.jpg

20180925220958863.jpg

20180925221005212.jpg

20180925221011577.jpg

FTIR: 1

20180925_220943_A.igm

IRLS: 1

2018_09_25_22_09_45_R_08 TA=18.0;TB=38.0;Gain=3

Gamma Runs: None

Run: 9 Time: 22:14:11 UTC

Alt: 3323 ft MSL Elev: 498 ft Elevation from DEM Database

Vel: 106 knots Heading: 173

Digitals: None

MSIC: 10

20180925221417622.jpg

20180925221423971.jpg

20180925221430320.jpg

20180925221436685.jpg

20180925221443034.jpg

20180925221449399.jpg

20180925221455748.jpg

20180925221502098.jpg

20180925221508462.jpg

20180925221514812.jpg

FTIR: 2

20180925_221415_A.igm

20180925_221455_A.igm

IRLS: 1

2018_09_25_22_14_17_R_09 TA=18.0;TB=38.0;Gain=3

Gamma Runs: None

Run: 10 Time: 23:43:56 UTC

Alt: 3446 ft MSL Elev: 509 ft Elevation from DEM Database

Vel: 119 knots Heading: 162

Digitals: None

MSIC: 10

20180925234402406.jpg

20180925234409660.jpg

20180925234416025.jpg
20180925234422374.jpg
20180925234428739.jpg
20180925234435088.jpg
20180925234440533.jpg
20180925234446882.jpg
20180925234453247.jpg
20180925234457786.jpg

FTIR: 2

20180925_234400_A.igm
20180925_234439_A.igm

IRLS: 1

2018_09_25_23_44_02_R_10 TA=19.4;TB=39.4;Gain=3

Gamma Runs: None

Run: 11 Time: 23:53:37 UTC

Alt: 1465 ft MSL Elev: 514 ft Elevation from DEM Database

Vel: 102 knots Heading: 146

Digitals: None

MSIC: 10

20180925235343460.jpg
20180925235349810.jpg
20180925235356174.jpg
20180925235402524.jpg
20180925235408888.jpg
20180925235415238.jpg
20180925235421602.jpg
20180925235427952.jpg
20180925235434301.jpg
20180925235440666.jpg

FTIR: 2

20180925_235340_A.igm
20180925_235419_A.igm

IRLS: 1

2018_09_25_23_53_42_R_11 TA=19.4;TB=39.4;Gain=3

Gamma Runs: None

Run: 12 Time: 00:02:17 UTC

Alt: 915 ft MSL Elev: 503 ft Elevation from DEM Database

Vel: 116 knots Heading: 94

Digitals: None

MSIC: 5

20180926000223694.jpg

20180926000230043.jpg

20180926000236408.jpg

20180926000242757.jpg

20180926000246392.jpg

FTIR: 1

20180926_000220_A.igm

IRLS: 1

2018_09_26_00_02_22_R_12 TA=16.1;TB=36.1;Gain=3

Gamma Runs: None

Run: 13 Time: 00:12:52 UTC

Alt: 1390 ft MSL Elev: 515 ft Elevation from DEM Database

Vel: 100 knots Heading: 153

Digitals: None

MSIC: 12

20180926001257416.jpg

20180926001304676.jpg

20180926001311035.jpg

20180926001317384.jpg

20180926001322828.jpg

20180926001329178.jpg

20180926001335542.jpg

20180926001341892.jpg

20180926001348256.jpg

20180926001354606.jpg

20180926001400955.jpg

20180926001407320.jpg

FTIR: 2

20180926_001255_A.igm

20180926_001334_A.igm

IRLS: 1

2018_09_26_00_12_57_R_13 TA=16.1;TB=36.1;Gain=3

Gamma Runs: None

Run: 14 Time: 00:48:10 UTC

Alt: 1677 ft MSL Elev: 515 ft Elevation from DEM Database

Vel: 111 knots Heading: 152

Digitals: None

MSIC: 12

20180926004816464.jpg

20180926004822813.jpg

20180926004829162.jpg

20180926004835527.jpg

20180926004841876.jpg

20180926004848241.jpg

20180926004854590.jpg

20180926004900940.jpg

20180926004907304.jpg

20180926004913654.jpg

20180926004920018.jpg

20180926004925463.jpg

FTIR: 2

20180926_004813_A.igm

20180926_004852_A.igm

IRLS: 1

2018_09_26_00_48_16_R_14 TA=16.1;TB=36.1;Gain=3

Gamma Runs: None

Appendix B.

Tabular Chemical Results

Ammonia

20180925_214930_A_igm

Estimated Detection Limit = 2.0 ppm

Scan	Latitude	Longitude	Concentration ppm
379	32.953154	-95.268715	2.162
380	32.953152	-95.268715	2.164
381	32.953150	-95.268714	2.031
382	32.953136	-95.268712	2.083
383	32.953064	-95.268698	2.006